SUMMARY REPORT

Hatchery Reform and Mass Marking Forum

AMERICAN FISHERIES SOCIETY, CALIFORNIA-NEVADA CHAPTER

43rd ANNUAL MEETING

Wednesday, April 1, 2009
8:00 am – 5:30pm
Hyatt Vineyard Creek, Santa Rosa, CA

Prepared by Eric Poncelet and Peter Harkema, Kearns & West
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I. INTRODUCTION: FORUM PURPOSE AND ORGANIZATION

This report summarizes key outcomes from the Hatchery Reform and Mass Marking Forum held April 1, 2009 at the California/Nevada Chapter of the American Fisheries Society meetings in Santa Rosa, CA.

Problem Focus of the Forum

Evidence increasingly shows that hatchery origin fish dominate California Chinook stocks. Hatchery fish are known to interbreed and compete with natural origin Chinook, reducing their abundance, fitness, and life history diversity. Thus, California Chinook salmon hatcheries are now recognized as a significant and persistent threat to the viability of natural origin Chinook salmon populations and fisheries (see "What caused the Sacramento River fall run Chinook collapse?" Lindley et al. 2009).

Primary Forum Objective

Achieve improved clarity regarding specific hatchery-related management actions that would significantly benefit natural origin Chinook and restore imperiled salmon fisheries.

Intended Outcomes

1. Identify specific management actions most likely to significantly improve fitness among California Chinook salmon without harming near-term hatchery production and fisheries.

2. Identify specific opportunities and challenges posed by mass marking[1] and hatchery reform in California.
3. Determine if and why mass marking hatchery fall run Chinook can or can not be implemented independently of mark-selective fisheries.

Forum Organization:

The forum was organized into two main parts. The forum opened with a brief description of the background of topics of hatchery reform and mass marking, as well as an overview of the purpose and objectives for the forum, as described above. In the morning, a variety of experts presented on elements of the forum topic. These presentations were organized into three main categories: (1) Hatchery Reform in the Pacific Northwest and Great Lakes, (2) Mark Selective Fisheries, and (3) California Harvest and Hatchery Management.

The afternoon of the forum was organized around two panel discussions. The first was focused on hatchery reform management actions, and the second was focused on mass marking and mark-selective fisheries. During the panel discussions, panel members addressed a series of pre-defined organizing questions. They also responded to questions posed by audience members.

The forum agenda, which includes a list of the presentations and the panel discussion members and questions, is included below as Appendix A.

The forum was facilitated and documented by Eric Poncelet and Peter Harkema of Kearns & West. This summary report represents our effort to synthesize issues and views expressed by forum participants. The report focuses on the key themes and issues for future discussion and is not intended to serve as a transcript of all issues discussed, possible pathways forward, or points made.

II. GENERAL OBSERVATIONS AND CROSS CUTTING THEMES

Over the course of the forum, participants expressed a variety of views on the broader topic of hatchery reform. Some of these views were recurrent, and we have tried to capture them here. These views are described in greater detail in the summaries of the presentations and panel discussions below.

- **Concern over status of California salmon**. Forum participants repeatedly stated that the situation of California's salmon is dire and that actions, beyond those currently in place, are essential to save and strengthen California Chinook runs. Participants expressed concern that, following the 2008 and 2009 closure of the California salmon fishery, there may be increasing pressure for federal Endangered Species Act listing of the Central

[1] Mass marking was defined for the forum as a process by which 100% of hatchery produced salmonids are made permanently and instantaneously identifiable as hatchery origin fish, and thus distinguishable from natural origin fish. Although a variety of marking, tagging or identification techniques exist, adipose fin clipping is the only proven and available method that provides immediate, visible identification of hatchery origin fish. Given these requirements, mass marking by adipose fin clipping is the only method currently in use among North American salmonid hatcheries producing millions of fish annually.

Valley fall Chinook runs. Such a listing would likely lead to a complete closure of the fishery and mandated changes to hatchery management.

- **Need for hatchery reform**. There was agreement among participants that hatchery reform is needed in California and that it has the potential to contribute to the recovery of diminishing Central Valley salmon runs. The potential benefits of a variety of hatchery reform actions (e.g. on-site releases, reducing hatchery fish on spawning grounds, genetic broodstock management, etc.) were discussed at length. Each of these will require additional discussion.

- **Diverse views on mass marking**. Participants emphasized a cautious but open view on mass marking of California Fall Chinook. There was also a general difference in the perspectives of participants focused on inland management of hatcheries and fisheries versus participants more focused on ocean fisheries management. Inland managers, for instance, tended to highlight the potential benefits from the instantaneous identification of hatchery and natural origin fish and how this could be used to better monitor and manage broodstocks and habitat access. Ocean managers, on the other hand, were more likely to express the concern that mass marking would inevitably lead to a mark selective fishery and increased pressure for additional fishing opportunity, which in turn has the potential to increase mortality.

- **Need for improved standardization of data and data collection**. Forum discussions revealed agreement that standardized data and data collection methods are currently lacking and that standardization would allow managers to more accurately monitor the current status of runs, the effectiveness of current management techniques, and the effectiveness of any future modifications to management practices.

- **Data gaps**. Participants identified a number of key data gaps, which, if filled, would help inform decision making regarding hatchery reform, mass marking, and mark selective fisheries. A primary example is hooking mortality data for mark selective salmon fisheries. Other examples included: percentage of natural origin Chinook that make up the Central Valley run as a total and by watershed, percentage of straying hatchery fish, average egg size, fish length, run timing, and accurate cost estimates for certain management techniques.

- **Role of genetics analyses**. Forum participants consistently identified managing genetics to maximize fitness as an essential focus for hatchery reform and hatchery management plans. There was considerable discussion of the negative impacts of current and past management actions that do not or did not take genetics into account. Key examples included egg/fish transfers, off-site releases, outdated broodstock selection practices, among others.

- **Need for critical examination of tradeoffs**. Group discussion brought to the surface the diverse interest that have a stake in the recovery and ongoing management of California's salmon populations. Participants agreed on the need to consider and address the multiple tradeoffs associated with the various proposed management actions. To this end, it will be necessary to bring the various interests together to have constructive and collaborative discussions on hatchery reform actions, mass marking, and mark selective fisheries.

Moreover, it will be necessary to establish criteria for evaluating the effectiveness of various actions that might be implemented. Development of such a tool will be particularly important for ocean managers, as no such tool currently exists.

- **Need for clear goal identification**. Discussions about the various management and reform strategies led participants to identify a need to define both near term and long term goals for California salmon and salmon hatcheries. Established goals would help define the appropriate management approach to achieve the goals.

- **Integrated approach**. Participants expressed the importance of considering salmon and salmon management decisions in a more integrated way that considers the full life cycle of the species (both ocean and inland).

- **Lessons learned from other regions**. The forum drew on the lessons learned and experiences from various regions outside of the California central valley and coast. Participants recognized the value of these lessons in shaping strategy for recovery of California salmon populations; however, participants also highlighted some differences in California fisheries. These differences may require a California specific strategy for hatchery reform and species recovery.

- **Leadership needed**. There was broad agreement among the forum participants that the forum was a positive step toward advancing the discussion of hatchery reform and notable in its effort to bring together inland fishery biologists, hatchery biologists, and ocean fishery managers. There was also broad agreement that future steps to address this issue will require some of the key agencies involved (e.g., NOAA Fisheries Service, California Department of Fish and Game) to take greater leadership roles in furthering discussions and implementing effective and timely management actions.

III. SUMMARY OF PRESENTATIONS

This section includes brief summaries of all of the forum presentations. The presentations were organized into three general sessions.

Session 1: Hatchery Reform in the Pacific Northwest and Great Lakes

Hatchery Reform in the Pacific Northwest: Applying Science to Hatchery Management (Lee Blankenship, Hatchery Scientific Review Group Co-Chair)

The Congressionally-established Hatchery Scientific Review Group (HSRG) offers a foundation for hatchery reform, to help salmon and steelhead hatcheries in the Pacific Northwest meet conservation and sustainable harvest goals. In order to address these twin goals, the HSRG determined that both harvest and hatchery reforms are needed.

The HSRG is recommending principles for hatchery management based on: 1) setting clear goals; 2) scientific defensibility; and 3) monitoring, evaluation and adaptive management. By applying these principles, the HSRG has demonstrated that hatcheries can be managed consistent with conservation goals, while still providing sustainable

economic benefits from salmon harvest. To be successful, managers will need to support both hatchery and harvest reforms, and funding entities will need to provide the investments needed for implementation. The HSRG has developed management tools to support application of these principles, including a scientific framework for artificial propagation of salmon and steelhead; benefit/risk assessments tools; hatchery operation guidelines; monitoring and evaluation criteria; and others. The primary analytical tool is the "All H Analyzer" (AHA), a Microsoft Excel-based application that allows managers to explore potential outcomes of alternative strategies of balancing hatcheries, harvest, habitat and hydroelectric system constraints. These tools are available for future use by managers.

The HSRG has used these products to review and provide recommendations for state, tribal and federal hatchery programs; first in Puget Sound and coastal Washington (2001-05) and more recently in the Columbia River Basin (2006-08). The HSRG's specific recommendations are not presented as the only possible solution, but rather as a clear demonstration that current hatchery programs can be redirected to better meet both conservation and harvest goals.

The HSRG concludes that in order for hatcheries to contribute to harvest on a sustainable basis, they must be operated in a manner that is compatible with conservation goals for salmon and steelhead resources at both the local and regional levels. These conclusions imply that hatcheries must be managed consistent with basic biological principles and viewed as integral components of the affected ecosystems.

The most central aspect of this approach involves genetic management, where hatchery broodstocks need to be managed as either genetically segregated from or integrated with natural populations. To guide this genetic management, the HSRG has developed standards that must be met—or preferably exceeded—regarding the level of hatchery influence on the natural populations under either type of hatchery program. The HSRG has also provided methods for meeting those standards.

The HSRG also prioritizes recommendations that assure ecological impacts of hatchery structures and operations are minimized and that they, at a minimum, meet all regulatory requirements (i.e., water withdrawal and discharge, fish passage and screening).

The HSRG concludes that hatchery reforms alone will not achieve recovery of natural populations—complementary actions taken by harvest, habitat and hydropower managers are all necessary if long-term conservation goals are to be achieved. The effectiveness of current habitat and future habitat improvements will be greatly increased if combined with hatchery and harvest reforms.

The HSRG recommendations, tools, and reports are available at www.hatcheryreform.us.

Tools for hatchery reform (Andy Appleby, Washington Department of Fish & Wildlife)

The All H Analyzer (AHA) is presented. An Excel based spreadsheet model developed by the HSRG, WDFW and Northwest Indian Fish Commission (NWIFC) used to calculate the direction and level of gene flow between hatchery and natural populations and estimate the resulting loss of fitness due to domestication. Theoretical bases for gene

flow and trait equilibrium is discussed (from Ford, 2002). Input and output sections of the model are reviewed and interpretation of results discussed. In addition, appropriate data sources, when and when not to use AHA as well as the history of application is presented. AHA is available at www.hatcheryreform.us

Mass Marking and Electronic CWT Recovery in the Pacific Northwest (Ron Olson, Northwest Indian Fisheries Commission)

Federal and State legislation now mandates the "mass marking" (MM) of Chinook, coho, and steelhead hatchery production in the Pacific Northwest. The primary purpose of this marking is to identify hatchery fish in mark selective fisheries (MSFs) and brood stock management. The adipose fin was selected as the "mass mark" to identify hatchery fish. This initiative has been contentious because the de-sequestering of the adipose fin mark (formerly reserved as the visual mark for identifying coded-wire tagged fish) has required major changes in the coded-wire tag (CWT) system. The challenges in implementing the MM initiative involved: 1) developing the logistics for annually marking 150 million hatchery fish, 2) converting CWT sampling to electronic tag detection, and 3) implementing a "Double-Index Tag" (DIT) program to measure the impacts of MSFs on wild stocks.

New mobile marking/tagging trailers were developed to mark the hatchery production in the limited time window available prior to release. These include manual fin marking trailers and high-tech automatic trailers. Northwest fisheries agencies have been successful in gearing up and conducting the actual mass marking of hatchery fish. MM is now comprehensive for hatchery coho and Chinook within Washington, Oregon, and Idaho. Coho marking began in 1996 and approximately 40 million fish are annually marked in southern British Columbia, Washington, and Oregon. Chinook marking began in 1998 and has annually increased in scope. Over 100 million Chinook are now annually marked in Washington, Oregon, and Idaho. Two types of electronic tag detection (ETD) devices have been developed, "wands" and "tubes", and field testing has demonstrated high rates of CWT detection. Due to issues of equipment cost, sampling logistics, and inter-agency coordination, CWT recovery by ETD has not been implemented throughout the entire range where MM fish are recovered. This has led to increasing impacts on agency CWT sampling programs that have not converted to ETD. Several of the coho and Chinook PST Indicator Stocks have now been converted to DIT programs. However, the DIT program has not received the desired level of support outside of Washington State. The current list of DIT stocks will need to be reviewed and expanded as MSFs expand. Costs for the regional program can be broken down into initial equipment costs ($30 million), and the annual marking and sampling costs ($5.5 million).

MM has provided fisheries managers with two new powerful tools: MSFs and the ability to differentiate hatchery and wild fish. Unfortunately, CWT marking, tagging, and sampling programs are no longer adequately synchronized between NW agencies. This has led to international concerns with maintaining the integrity of the CWT system.

Development and implementation of a monitoring program for mark-selective Chinook salmon fisheries in Puget Sound (Mark Baltzell, WDFW)

In the Pacific Northwest, mass marking (adipose fin-clipping) of hatchery stocks of Chinook salmon has increased steadily since the listing of Puget Sound Chinook on the endangered species list in 1999. With the implementation of mass marking on hatchery Chinook, recreational fishery managers have implemented mark-selective fisheries as a tool for harvesting abundant hatchery stocks while minimizing impacts on unmarked or wild stocks. These fisheries require that anglers release any Chinook that has an in-tact adipose fin and they may retain Chinook with a clipped adipose fin. The development and implementation of a comprehensive monitoring program arose in Washington State out of the need for fishery managers to have reliable estimates of mortalities on fish that are caught and released.

The Puget Sound Sampling Unit within the Washington Department of Fish and Wildlife (WDFW) has implemented comprehensive monitoring programs for recreational Chinook mark-selective fisheries since 2003. The sample design for each fishery/area is based on Murthy's population total estimator employing on-the-water effort surveys, dockside (creel) sampling, a test fishery, and a voluntary angler report program. Each of these sampling regimes allows biologists to estimate the total Chinook encounters (retained + released) for each fishery/area. Chinook mortality rates (15% for legal-size and 20% for sub-legal size) are then applied to the estimates of released encounters, which when added to the estimate of retained Chinook, yields total fishery mortality estimates. These field-estimated mortalities are then compared to expected values from the Fishery Regulation Assessment Model (FRAM), which is used by fishery managers to predicted fishery outcomes (Chinook landings, encounters, mortalities).

To date, WDFW has implemented 18 comprehensive monitoring studies to evaluate mark-selective Chinook fisheries in catch areas throughout Puget Sound. These fisheries have met the objectives of mark-selective Chinook fisheries in Washington State, such as maintaining or decreasing impacts on unmarked Chinook salmon, increasing angler opportunity, and increasing harvest of abundant hatchery Chinook stocks. All of the data collected from sampling and monitoring programs to date has shown that mortalities from these fisheries are consistently less than what the FRAM model predicts and that these programs are more than adequate for achieving fishery estimates within agreed-to levels of precision. WDFW has shown that recreational Chinook mark-selective fisheries are proving to be an effective tool enabling increased opportunities for anglers to harvest hatchery fish while minimizing impacts on wild stocks in need of conservation.

A coordinated mass marking program for salmonines stocked into the Laurentian Great Lakes (Charles Bronte, US Fish & Wildlife Service)

Fishery managers in the Laurentian Great Lakes annually stock over 30 million salmonines (salmon and trout) to diversify sport fisheries, restore native fish populations, and control invasive fishes. However, little is known about how well these fish survive, contribute to the fisheries, and levels of natural reproduction by naturalized non-native salmonines. As a result, the Council of Lake Committees (CLC), a basin-wide group of fishery managers that operates under the auspices of the Great Lakes Fishery Commission, agreed in 2005 to develop a basin-wide program to mark all stocked salmonines. This marking effort would provide greater insight into survival of stocked

fish, the contribution of stocked adults to restoration of native fishes, the ability to manage harvest away from wild fish, and the opportunity to evaluate and improve hatchery operations. After evaluating the available marking and tagging options, the CLC chose to pursue mass-marking of all stocked salmonines using adipose fin-clips and coded-wire tags, using the program for marking Pacific salmon (Oncorhynchus sp.) in the northwest United States as a model. If fully developed, the program will require nine automated trailers and four manual trailers to mark and tag all 31 million fish. Total costs (2007 U.S.) for equipment would be $13.7 million. Annual operations including tags, recovery efforts, and tag extraction services, would cost about $6.5 million. An operational plan has been completed to mark all fish prior to stocking, recover tagged fish as part of regular fishery surveys, from anglers, commercial fishers, and charter boat operators. A data management system will be developed to cooperatively archive and analyze recovery data to answer questions of lake-wide or basin-wide scope. Efforts are underway to communicate to stakeholders the benefits of mass marking and to secure the necessary funding for equipment and annual operations. Project leaders expect this program to be fully implemented within five years but that schedule is predicated on funding levels and subsequent agency commitment. This project is an excellent example of cooperative, proactive efforts to improve and refine fishery management across the Great Lakes basin.

Session 2: Mark Selective Fisheries

Tools and data requirements for estimating impacts from mark-selective fisheries (Kristen Ryding, Ph.D., Washington Department of Fish and Wildlife)

Mark-selective fisheries is a management tool that allows for the exploitation of marked, hatchery salmon while minimizing impacts on protected, wild stocks. The result is that recreational and some commercial fishing can continue in areas where wild fish are protected. However, initiation of mark-selective fisheries generated concern about impacts on the integrity of the coded wire tag (CWT) and indicator stock programs. In particular, tagged hatchery stocks can no longer be assumed to represent the natural stocks because the nature of a selective fishery creates a higher harvest mortality of hatchery fish. In addition, some of the released unmarked fish die, and unlike harvested fish, are not available for sampling. Thus the catch and release mortality of unmarked fish requires an indirect methods of estimation in a selective fishery. To cope with these new challenges to the CWT system, the PSC established a Selective Fisheries Evaluation Committee (SFEC). Use of double index tag (DIT) groups of hatchery fish provides a tool for estimating the impacts of mark-selective fishing on un-marked fish.

A DIT group is comprised of sub-groups of marked and un-marked fish all having a CWT. The key assumption that allows adjustments on exploitation rates for unmarked fish, and hence wild stocks is that the only difference between marked and unmarked fish in a DIT group is fishing mortality. This assumption requires that handing, tagging, release, and recovery at the hatchery be equal between the two groups. The key pieces of data required to estimate the number of unmarked mortalities in mark-selective fisheries are,

1. The ratio of marked to unmarked fish in a CWT group, either at release, in the fishery, or in the escapement.

2. The incidental hook and release mortality (usually an agreed to value by co-managers).
3. The number of marked fish encountered in the fishery.

The ratio of marked to unmarked fish in a CWT group is a key part in calculating fishery exploitation rates. The information required to estimate total impacts is the proportion released of marked and unmarked DIT group fish returning to the hatchery. Hence, unbiased estimates of exploitation rates and selective fishing mortality require accurate sampling or enumeration of the numbers of tags from both marked and unmarked fish in each DIT group returning to the hatchery.

Implementing a mark selective fishery would require to following elements to meet data needs,

1. CWT and/or DIT tagging programs
2. CWT recovery programs (electronic tag detection , fisheries, hatcheries and spawning grounds)
3. Indirect estimation method agreed to by all stakeholders (including *sfm*)
4. Monitoring plan
5. Cooperation among agencies

In the review of DIT data for coho brood years 1995-1997, recommendations were suggested by the SFEC for sampling fish returning to the hatchery (Joint Coho DIT Analysis Workgroup 2003, PSC):

Mass Marking and Mark-Selective Fisheries: A black and white choice, or complex shades of gray? (Dave Hankin, Ph.D., Humboldt State University)

As practiced in the Pacific Northwest, "Mass Marking" (MM) consists of releasing all hatchery fish with an adipose fin clip; not all of these fish are given CWTs. The historic intention of Mass Marking was to allow Mark-Selective Fishing (MSF) which restricts retention to fish with adipose fin clips. A Pacific Salmon Commission Expert Panel (2005) documented the numerous negative impacts of MM & MSF on the coded wire tag recovery system. The consequent inability to unbiasedly estimate non-catch mortality rates on unmarked natural stocks is of special concern when exploitation rates on marked fish are anticipated to be high, as they would be in central CA ocean fisheries.

MM is currently being promoted in CA as a method to allow adoption of new hatchery reform measures that require immediate identification and separation of hatchery and wild fish in the spawning escapement (HSRG 2004). I argue that it would be impossible to resist mark-selective fishing if CA salmon hatcheries adopted MM programs similar to those adopted elsewhere in the Pacific Northwest. I further argue that an alternative MM regime would promote the hatchery reform measures that have been proposed, but would not lead to mark-selective fisheries and would not negatively impact the coded wire tag recovery system. For this alternative method of MM, all fish in excess of current Constant Fractional Marking releases (which are adipose clipped and coded wire tagged) would not be adipose clipped but would instead be tagged with blank wire. On the spawning grounds and hatcheries, wands or tube detectors could be used to screen all fish with intact adipose fins.

Finally, I argue that other hatchery reforms, including an elimination of SF Bay releases and a shift to on-site release of hatchery fish, are more important elements of needed hatchery reforms at Central Valley salmon hatcheries.

Ocean Salmon Management Implications of Mass Marking/Mark Selective Fisheries (Michael O'Farrell, Ph.D., NMFS)

Mass Marking (MM) and Mark-Selective Fisheries (MSF) have recently been forwarded as a potential strategy for Chinook salmon management in California. It has been argued that MM/MSF has the potential to increase overall harvest, while simultaneously reducing impacts on naturally reproducing and/or Endangered Species Act (ESA) listed stocks. The overall goal of our presentation was to evaluate the implications of MM/MSF on California salmon fishery management and assessment. Below, we describe the four central themes of our presentation.

MM will lead to strong pressure for MSF. Ocean salmon fisheries are managed by the Pacific Fishery Management Council (PFMC). PFMC has managed salmon fisheries by the principle of maximizing fishing opportunity, while meeting conservation objective (Fishery Management Plan stocks) and consultation standard (ESA listed stocks) constraints. If MM were implemented, harvest opportunity would likely be maximized by implementing MSF. Hence, the practices of MM and MSF are strongly linked.

Management issues with MSF. MSF would not likely lead to the simultaneous realization of increased harvest and higher levels of protection for natural/listed stocks, owing to the principle of maximizing fishing opportunity subject to fishery management plan and ESA constraints. Under a MSF, fishing effort would increase to a level where mortality rates for the most constraining ("weak") stocks are met by the accumulation of release mortality impacts. Therefore, no increased protection for unmarked stocks would be expected. In addition, MSF would not likely lead to increased fishing opportunity in all areas and fishery sectors. Some increased fishing opportunity may occur for commercial fisheries, particularly in the San Francisco and Monterey regions, but little increase in opportunity is possible for recreational fisheries. Finally, the current practice of marking and coded-wire tagging listed Chinook stocks would have to be discontinued under a MSF, since targeting of listed stocks is not permissible.

Assessment issues with MSF. Current salmon assessment based on coded-wire tag recoveries assumes that the natural component of a stock has the same fishing mortality rate as the hatchery component of that stock (i.e., the hatchery stock serves as a proxy for the natural stock). This assumption is not valid for a MSF, because releasing unmarked fish results in the marked and unmarked groups having separate mortality rates. Without additional programs to sample unmarked fish (e.g., Genetic Stock Identification for released fish), direct estimation of harvest and impact rates for unmarked stocks is not possible.

Recent fishery disasters could not have been avoided by MSF. It has been suggested that MSF could have allowed fishing opportunity during the recent salmon "disaster" years when fishing was prohibited or severely limited. However, both the 2006 and 2008 salmon disasters were the result of abundance shortfalls for Klamath River fall Chinook

(2006) and Sacramento River fall Chinook (2008), to the extent that these stocks were not forecast to meet their escapement objectives in the absence of any fishing. As a result, imposition of MSF would not have allowed for increased fishing in these years.

Session 3: California Harvest and Hatchery Management

Mass Marking of Hatchery Chinook and Mark-Selective Fisheries in California (James Phillips, California Department of Fish and Game)

The mass marking (MM) of all hatchery Chinook salmon in California by removing the adipose fin creates an array of logistical and financial concerns for salmon monitoring programs throughout California. In 1977, all management agencies on the west coast agreed to sequester the adipose fin clip (ad-clipped) as the visual mark signaling the presence of a coded-wire tag (CWT) in a salmonid. CWT data are a critical component of salmon management in both the United States and Canada. In addition, the agencies agreed to sample the ocean catch at a minimum 20% rate to ensure the recovery of "rare" CWTs from salmon stocks of special concern. If MM were instated without a 100% CWT rate, visual detection for CWTs would no longer be possible. All salmon monitoring programs would be required to switch to electronic tag detection (ETD). This shift would require substantial start up costs to purchase ETD equipment and a long-term, stable funding base for significantly increased staffing needs.

To estimate the impact of MM on California's marine sampling programs, actual sample data from the 2004 ocean salmon season was used since this was the last year that both the commercial and recreational ocean fisheries were relatively unconstrained by weak stock management. An estimated 700,000 Chinook salmon were harvested by both fisheries, of which the CDFG sampled 175,000 fish during dockside monitoring. Approximately 10% (16,850) of these fish were ad-clipped, signally the sampler to remove the head for subsequent CWT removal and processing.

Assuming MM would result in approximately 85% of California's ocean harvest being ad-clipped, a repeat of the 2004 season would result in more than 148,000 ad-clipped salmon being observed during dockside monitoring. Each of these salmon would have to be scanned using ETD equipment to determine if it contained a CWT. The CDFG estimates the start up costs of ETD equipment at about $1 million and the annual staffing costs for monitoring ocean fisheries at almost $9 million.

Similar increases in costs apply to inland monitoring programs as well; however, costs would be more variable throughout the Central Valley (CV), primarily dependent upon the use of segregation weirs. It is unclear if weirs will be needed only on rivers that support hatcheries or if they will be needed on all CV rivers and tributaries. Under MM, inland monitoring programs will also require ETD for CWT recovery. In 2004, approximately 136,000 and 40,000 Chinook were sampled at CV hatcheries and in river escapement surveys, respectively. Of these, 16,800 (9%) were ad-clipped. With MM, almost 150,000 of these returning Chinook would be ad-clipped and recovery of CWTs would require ETD. The logistics surrounding initial weir costs, weir placement, installation timing, and staffing needs are unique to each river. Other considerations such as high flows, reduction in inland fishing opportunity, boat traffic and weir effects on other native fish species may prevent or limit the use of weirs on some rivers. Depending

on weir usage, the initial start up costs and annual staffing for inland monitoring range from $15 to $20 million.

At this time, the funding source(s) for these additional costs are uncertain. In addition, there is confusion on how MM can actually be used as a management tool for California fall Chinook salmon stocks. A comprehensive assessment of funding sources, staffing levels, and multi-agency coordination of the program should be completed before any mass marking of California's fall Chinook is implemented.

Central Valley salmonid hatcheries: Problems and potential solutions (Dennis Lee, retired California Department of Fish and Game)

One of the major factors affecting the abundance and distribution of anadromous salmonids in the Central Valley has been the reduction and degradation of available in river habitat. Yoshiyama et al (2001)[2] reported that an estimated 2,183 miles of river and streams habitat was historically available Chinook salmon and Reynolds et al (1993)[3] reported that the total amount of existent spawning habitat for salmon and steelhead in the Central Valley drainage was estimated to be less than 300 miles.

Construction of state and federal water projects is largely responsible for the reduction in available habitat and numbers of fish. Mainly due to design considerations, no access to upstream habitat was provided and five anadromous fish hatcheries were constructed to mitigate for the loss of habitat for specific projects. Unfortunately, habitat improvement, and fishery and hatchery management has not adapted to the growing crisis of imperiled wild salmon stocks.

Recognizing that habitat and water management issues are the major factor responsible for the overall decline in Central Valley anadromous fish populations and that hatchery reform can help to maintain fish populations and fisheries, I suggest five areas that need to be addressed.

1. Completion and implementation of Hatchery and Genetic Management Plans as described in NOAA Fisheries Science ESA salmon and steelhead 4(d) rule. The plans provide a framework for management while ensuring that listed populations are not affected by hatchery operations.

2. Revise hatchery policies to help recover wild populations and support sustainable fisheries with emphasis on natural habitat improvement. Current policies are vague and have no clearly stated objective other than meeting production goals.

3. Ensure hatchery origin fish do not present a risk to anadromous salmonid stocks protected under the federal Endangered Species Act by changing hatchery produced fish release locations, methods, and time to reduce straying; reduce contribution of

[2] Yoshiyama, R.M., E.R.Gerstung, F.W. Fisher, and P.B. Moyle. 2001. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. California Department of Fish and Game Fish Bulletin 179(1):71-176.

[3] Reynolds FL, Mills TJ, Benthin R, Low A. 1993. Restoring Central Valley streams; a plan for action. Sacramento (CA): California Department of Fish and Game. 129 p.

hatchery origin fish to natural spawning; Increase number of natural origin fish on spawning grounds, and control access to spawning grounds and collect natural origin fish for hatchery broodstock.

4. Improve and enhance monitoring of fish collected through an expanded and consistent collection of genetic material and with timely analysis, routine collection of fish structural and other indices such as length, weight, age, run timing information at all hatcheries and implementation of a total marking program for Chinook salmon is required.

5. Revise mitigation goals and hatchery "success" from juvenile fish produced to adult fish contribution and return.

Present mitigation goals are for the production and release of 30 million fall Chinook salmon smolt sized fish from the five mitigation hatcheries; 2 million spring Chinook salmon smolts from Feather River Hatchery; 1 million advanced late fall Chinook salmon smolts from Coleman National Fish Hatchery; 250,000 advanced winter Chinook salmon smolts from Livingston Stone National Fish Hatchery; and 1.5 million yearling steelhead from Coleman, Feather River, Nimbus and Mokelumne hatcheries. More effective mitigation goals would be for estimated contribution of adult fish to the ocean and inland fisheries, minimum contribution to the natural spawning populations, and contribution to the broodstock programs and all hatcheries.

In conclusion, although it is fairly easy to identify hatchery reform issues and actions, implementation will be difficult due existing California politics, entrenched special interests, higher priorities for agencies involved, and competing funding issues.

IV. SUMMARY OF PANEL DISCUSSIONS

PANEL 1: HATCHERY REFORM MANAGEMENT ACTIONS

Panelists included:

- Pete Adams (NMFS Southwest Fisheries Science Center)
- Andy Appleby (Washington Department of Fish and Wildlife)
- Dave Hankin (Humboldt State University)
- Dennis Lee (retired California Department of Fish and Game)
- Neil Manji (California Department of Fish and Game)

Note: The meeting agenda listed Brad Cavallo (Cramer Fish Sciences) on this panel, but Brad was traded out for Dave Hankin, who needed to leave early and would be unable to participate in the second afternoon panel.

<u>Hatchery Reform Management Actions</u>

Panel members were asked to identify specific hatchery reform management actions that would most effectively improve fitness and genetic diversity among both hatchery broodstock and natural spawning Chinook salmon in California. To help stimulate this discussion, the panelists

were provided with a list of potential hatchery reform actions for reflection (these are listed in Appendix A below).

The panelists identified several primary hatchery reform actions as likely to improve fitness and genetic diversity; each received considerable discussion among the panelists and the audience. While there was some disagreement about the ordering of management actions to achieve improved fitness and genetic diversity, the panelists generally agreed that all were important components in the recovery of California salmon runs.

The following includes key hatchery reform management actions suggested by the panelists and forum participants to help improve fitness and genetic diversity:

- *Change hatchery release practices.* Panelists generally agreed that on-site or in-river releases of hatchery salmon have the potential to minimize straying between watersheds and hatcheries, thereby minimizing interbreeding among hatchery and natural origin stocks and improving genetic diversity of natural origin stocks. Releases in San Francisco Bay were recognized as beneficial for survival of hatchery fish, but were also seen to increase straying to non-natal rivers, thereby damaging the fitness and genetic diversity among natural origin and ESA listed stocks.

- *Stop egg/fish transfers between facilities.* Egg and fish transfers between hatchery facilities are viewed as contributing factors to increased homogeneity among Central Valley salmon runs. Efforts to improve hatchery or river specific fitness and genetic diversity require that egg and fish are not continually transferred in from other hatcheries. Egg and fish transfers may be appropriate or necessary in founding new populations or in supplementing hatcheries where local adaptation and fitness is not a goal of the hatchery program. However, as indicated previously, it will be important to minimize out of basin straying in these circumstances.

- *Implement mass marking.* Mass marking could be an effective tool to help managers improve fitness and genetic diversity because it would provide the ability to instantaneously determine whether a fish is hatchery or natural origin. This would provide such opportunities as including natural origin fish in hatchery broodstock, and limiting hatchery fish access to spawning grounds. However, several participants also expressed concern that mass marking would likely lead to the implementation of an ocean mark selective fishery, which they believed would ultimately be detrimental to efforts to restore salmon runs, due to potential increased fishing effort and greater uncertainty regarding fishing mortality of unmarked salmon.

- *Implement segregation weirs.* Several speakers described the importance of managing not just broodstock in hatcheries, but also limiting the proportion of hatchery fish on the spawning grounds. Even with all in-river releases and extremely low straying rates, rivers home or proximal to one of the five Central Valley Chinook salmon hatcheries will continue to experience high densities of hatchery origin fish. These hatchery origin fish compete and interbreed with natural origin fish, thereby impairing genetic diversity and fitness of the natural stock. Some participants suggested that placement and operation of segregation weirs would make it possible to limit the number of hatchery origin Chinook reaching the spawning grounds. Segregation weirs may be an especially important tool

- *Develop standardized operating protocols for hatcheries and systematic monitoring and data collection methods.* Fisheries managers should work collaboratively to develop operating protocols to be implemented in all Central Valley hatcheries. In addition, managers should be conducting systematic monitoring of everything from genetics to egg size and fish length.

- *Create a representative committee to discuss possible hatchery reform actions and make recommendations.* Increased discussion of these topics will be essential to developing a plan and implementing hatchery reform actions. It is essential that any discussion include all of the varied interests, including inland and ocean managers, as well as hatchery managers. The Great Lakes "Council of Lake Committees" might be a helpful model to follow.

Mass Marking

Panelists were also asked what additional information would be needed (if any) to determine whether or not mass marking hatchery fish is an appropriate or necessary management action. Panelists expressed a variety of opinions; while some felt that there is currently sufficient information to implement mass marking, others expressed an interest in gathering more information before considering mass marking of all hatchery Chinook salmon.

The information recommended included the following:

- *Establish clear and precise goals for California's salmon hatchery program.* Some panelists felt that if mass marking of hatchery salmon were to be considered, then it would be important that the State discuss and establish clear goals for the hatchery program. Different management actions (e.g., mass marking) might result from different goals. This discussion would need to address such topics as:
    - Is the primary function of hatcheries conservation or mitigation?
    - Is the goal of Central Valley hatcheries to create productive fishers (recreation? commercial?) or promote run recovery?
    - How should mitigation requirements be addressed?
    - What is the desired level of integration if mass marking were implemented?
    - Are there priority runs or "stronghold runs" that should receive special treatment?

  Others pointed out that existing legal constraints established in sources such as recovery plans may sufficiently define these goals. While recognizing the value of establishing clear goals, still others questioned how these goals would alter conclusions about whether mass marking hatchery fish is an appropriate or necessary management action.

- *Obtain additional information on the impacts (either positive of negative) of mass marking and mark selective fisheries.* Some panelists felt that mass marking would lead inevitably to a mark selective fishery. As such, to implement mass marking would require additional information on the impacts of mark selective fisheries (e.g., hooking mortality rates for various gear types).

- *Consider alternatives before implementing mass marking program.* Alternative methods might provide for the same benefits while not allowing for a mark selective fishery. For example, a "mass tagging" program could be conducted by marking and inserting a coded wire tag (CWT) into 25% of fish released and then placing a blank wire tag in the other 75% of fish released while leaving them unmarked. Such a program would make it possible to maintain the current Constant Fractional Marking (CFM) program, gain some of the benefits of mass marking, while eliminating any possibility of a mark selective fishery. While this option is desirable from the ocean management perspective of avoiding mark selective fisheries, it was viewed as less satisfactory by inland management because it also precludes freshwater mark-selective fisheries and complicates the simplicity of visual hatchery-natural origin stock assessment provided by mass marking. Nevertheless, participants were intrigued by the concept of mass tagging and agreed to give it further consideration. Others were very interested to see what the impacts of in-stream or on-site releases of hatchery fish might be prior to implementation of a mass marking program. Still others questioned what novel information would be provided that would alter conclusions about the value of mass marking.

- *Develop a process to address hatchery concerns.* It may be useful to convene a group to continue to discuss these important issues described above. The Hatchery Genetic Management Plan might be a good starting place for this.

When asked how long it might take to complete the evaluations described above and make an informed policy decision regarding mass marking, responses varied. Among panelists who felt these actions would be necessary, there was general agreement that the status of California fall Chinook necessitate quick action; however, no clear timeline for implementation was suggested.

Panelists were also asked if there is information indicating that mass marking hatchery Chinook either is or is not an appropriate or necessary action to preserve California salmon populations. There was no clear agreement among the panelists as to whether mass marking was a necessary or appropriate action. Some expressed the view that sufficient information exists to require immediate mass marking of all Central Valley hatchery salmon. Others were more skeptical of mass marking and called for a more cautious approach. Among the key themes expressed by the panelists and audience members were the following:

- *Mass marking would likely result in pressure for additional angling opportunities.* Some participants suggested that mass marking would lead to pressure for increased fishing opportunity and that increase in fishing opportunity could result in a subsequent increase in fishing mortality for natural origin and ESA stocks.

- *Mass marking would allow for the implementation of many other important hatchery reform actions.* Mass marking would have the benefit of allowing managers to implement other hatchery reform actions such as limiting hatchery fish access to

spawning habitat and managing genetic segregation/integration at desired levels. Some participants said they would be more open to mass marking after seeing the effects of on-site releases of hatchery fish. Other participants observed that this period of observation was unnecessary because the benefits of in-river releases are sufficiently understood with regard to minimizing adverse hatchery effects. These participants stated that additional hatchery reform actions were necessary in the five rivers that host hatcheries and would continue to receive large numbers of hatchery origin fish, even if out-of-basin straying was reduced to zero.

- *Mass marking may or may not invariably lead to a mark selective fishery.* Mass marking and selective fishing do not have to be linked. Moreover, different choices might be made for ocean and inland fisheries (e.g., mark selective inland, not mark selective ocean).

PANEL 2: MASS MARKING AND MARK-SELECTIVE FISHERIES

Panelists included:

- Pete Adams (NMFS Southwest Fisheries Science Center)
- Lee Blankenship (Northwest Marine Technology, HSRG Co-Chair)
- Carlos Garza (NMFS Southwest Fisheries Science Center)
- Michael O'Farrell (NMFS Southwest Fisheries Science Center)
- Kristen Ryding (Washington Department of Fish and Wildlife)

Note: Michael O'Farrell was added to this panel to replace David Hankin, who replaced Brad Cavallo in Panel 1.

Panel members were asked if mark-selective fisheries would be harmful or beneficial to ESA-listed and natural origin salmon relative to current harvest management practices. Key themes raised by the panelists and forum participants included:

- *Mark selective fisheries can be neutral, beneficial, or harmful to ESA species and natural origin stocks.* Harvest management is the key factor, and it is (or should be) dictated by fisheries managers. If a conservative threshold level of harvest (or take) is believed to have been met, then the fishery could be closed.

- *A key component of preservation of ESA listed stocks is maintaining their genetic identity.* A mark selective fishery may help limit the number of hatchery fish that reach spawning grounds, which would help preserve natural origin salmon genetics.

- *Likely to see the status quo or increased harm to ESA-listed stocks due to increased fishing pressure.* Implementing a mark selective fishery would likely be met with a strong push from both the recreational and commercial fishing communities for increased fishing opportunities. The possible resulting increase in fishing opportunity could cause either equal or greater impact on ESA-listed stocks due to increase mortality associated with increased fishing effort.

- *Genetic analysis is an important tool to help monitor and manage ocean harvest.* Eventually, genetic techniques may complement or replace mass marking and coded wire

tagging. Marking and tagging may have detrimental fitness consequences that would be avoided through the use of genetic techniques.

When asked if it would be appropriate or possible to mass mark hatchery Chinook and not implement mark-selective fisheries, panelist responses included:

- *Yes, it is possible, but not politically likely.* A commonly expressed view was that it would be possible to mass mark hatchery Chinook and not implement mark-selective fisheries , but that mass marking would also bring considerable political pressure to have a mark selective fishery. In response, some forum participants pointed to certain treaty fisheries in the Pacific Northwest that do not have a mark selective fishery but also are harvesting in the mass marking systems. Also, ocean fisheries already successfully operate with size (sublegals) and species selective fisheries (Coho). Other participants reminded the group that there are many differences biologically and politically between California and the Pacific Northwest.

- *It may be possible to implement a mark selective inland fishery and a non-mark selective ocean fishery.* With mass marking, it would be possible to implement mark-selective fisheries. While the effectiveness and desirability of ocean mark-selective fisheries is contentious and poorly understood, participants did not see similar problems with inland (i.e., freshwater) mark-selective fisheries. Several participants pointed out that inland mark-selective fishing for Central Valley steelhead (which have been mass marked for nearly a decade) have been effective. The option of having a mark selective inland fishery and a non-mark selective ocean fishery appeared to be a relatively new idea for some participants at the forum.

Panelists were then asked to provide information they considered necessary to seriously evaluate or implement mark-selective ocean fisheries off California. The key data gaps identified were as follows:

- *Improved information on the impacts of on-site releases.* While it is generally viewed that off-site releases have contributed to straying and genetic intermixing of stocks, some participants thought it would be helpful to know more about the impacts that on-site or in-river releases have in counteracting straying among Central Valley Salmon stocks. Others questioned whether this information was critical to evaluating mark-selective fisheries off California.

- *Models or real life examples that provide comparable data.* It would be of great value to evaluate data of a mark selective fishery in a situation similar to California. Some inferences may be made from such similar examples in Washington State, but a large coastal fishery with mixes stocks is difficult to replicate.

- *Genetic information about the stocks.* Additional information about the status of the various stocks would be very useful. Some participants expressed concern that "wild" fall Chinook may no longer exist in the Central Valley, while others were hopeful that the unique ability of salmon and steelhead to adapt may provide opportunity for preservation. Additional information about the fish returning to various watersheds and hatcheries will be essential in helping to shape management decisions, including possible prioritization

of certain stocks. The integrated genetic stock identification work done by Carlos Garza and others may provide a useful tool to accomplish this.

- *Improved run forecasting and modeling.* Improved forecasting and modeling would allow more precise and targeted management decisions.

- *Gear specific hooking mortality estimates*. It would be very helpful to have precise data on hooking mortality of natural origin salmon; however, gathering this data will be very difficult due to the need for a control (i.e., natural fish known not to have been caught or hooked).

- *Effectiveness of new technologies.* There are certain devices that may improve the viability of a mark selective fishery (e.g., on-boat fish recovery tanks, "real time" genetic identification) that may improve the viability of a mark selective fishery.

V. NEXT STEPS

There was broad agreement among the forum participants that the forum was a good step toward advancing the discussion of hatchery reform, but that additional discussion on the topic is required to better address the many tradeoffs that exist. There was also general agreement that future steps will require some of the key agencies involved (e.g., NOAA Fisheries Service, California Department of Fish and Game) to take greater leadership roles in organizing and convening additional discussions and that these discussions will need to involve managers, scientists, and stakeholders (e.g., fishing and conservation interests). Participants were hopeful that additional discussions on hatchery reform would take place soon.

APPENDIX A: AGENDA AND PANEL DISCUSSION QUESTIONS

AMERICAN FISHERIES SOCIETY, CALIFORNIA-NEVADA CHAPTER

43rd ANNUAL MEETING

Hatchery Reform and Mass Marking Forum

Wednesday, April 1st 2009
8:00 am – 5:30pm
Hyatt Vineyard Creek, Santa Rosa, CA

Problem Focus

Evidence increasingly shows that hatchery origin fish dominate California Chinook stocks. Hatchery fish are known to interbreed and compete with natural origin Chinook, reducing their abundance, fitness, and life history diversity. Thus, California Chinook salmon hatcheries are now recognized as a significant and persistent threat to the viability of natural origin Chinook salmon populations and fisheries (see "What caused the Sacramento River fall run Chinook collapse?" Lindley et al. 2009).

Primary Forum Objective

Achieve improved clarity (not necessarily agreement) regarding specific hatchery-related management actions that would significantly benefit natural origin Chinook and restore imperiled salmon fisheries.

Intended Outcomes

1. Identify specific management actions most likely to significantly improve fitness among California Chinook salmon without harming near-term hatchery production and fisheries.
2. Identify specific opportunities and challenges posed by mass marking and hatchery reform in California.
3. Determine if and why mass marking hatchery fall run Chinook can or can not be implemented independently of mark-selective fisheries.

Background

Mass marking is a process by which 100%of hatchery produced salmonids are made permanently and instantaneously identifiable as hatchery origin fish, and thus distinguishable from natural origin fish. Although a variety of marking, tagging or identification techniques exist, adipose fin clipping is the only proven and available method that provides immediate, visible identification of hatchery origin fish. Given these requirements, mass marking by adipose fin clipping is the only method currently in use among North American salmonid hatcheries producing millions of fish annually.

Possible Hatchery Actions Table (for reference and discussion)

Potential Hatchery Actions	**Desired Outcomes: General**			**Desired Outcomes: Hatchery Rivers[2]**			**Desired Outcomes: Non-Hatchery Rivers[3]**	
	Satisfies hatchery mitigation requirements?	Improves survival and abundance of hatchery salmon?	Reduces harvest of natural origin or ESA salmon?	Improves fitness among hatchery salmon?	Improves fitness among natural origin salmon?	Improves genetic differences between tributaries?	Improves fitness among natural origin fish?	Improves genetic differences between tributaries?
Stop egg/fish transfers between hatcheries								
Expand egg/fish transfers between hatcheries								
Implement in-river releases								
Expand bay releases								
Implement variable release timing								
Implement natural rearing practices								
Reduce number of hatchery fish produced								
Manage natural/hatchery broodstock composition[1]								
Manage hatchery fish access to spawning habitat[1]								
Implement mark-selective fisheries[1]								

[1]*Actions requiring mass marking of hatchery fish*

[2]*Sacramento River, Battle Creek, American River, Feather River, Mokelumne River, Merced River*

[3]*Butte Creek, Deer Creek, Mill Creek, Clear Creek, Yuba River, Stanislaus River, Tuolumne River*

AGENDA

8:00 AM Forum Introduction – Objectives and Anticipated Outcomes (Brad Cavallo, Cal-Neva AFS Chapter President & Eric Poncelet, Kearns & West, forum facilitator)

8:20 Early Morning Session: Hatchery Reform in the Pacific Northwest and Great Lakes

- Hatchery Reform in the Pacific Northwest: Applying Science to Hatchery Management (Lee Blankenship, Hatchery Scientific Review Group Co-Chair)
- Tools for hatchery reform (Andy Appleby, WDFW)

Clarifying Questions (10 minutes)

- Mass Marking and Electronic CWT Recovery in the Pacific Northwest (Ron Olson, Northwest Indian Fisheries Commission)
- Development and implementation of a monitoring program for mark-selective Chinook salmon fisheries in Puget Sound (Mark Baltzell, WDFW)
- A coordinated mass marking program for salmonines stocked into the Laurentian Great Lakes (Charles Bronte, USFWS)

Clarifying Questions (10 minutes)

10:25 Morning Break (coffee and breakfast snacks)

10:40 Late Morning Session: Mark Selective Fisheries

- Tools and data requirements for estimating impacts from mark-selective fisheries (Kris Ryding, Ph.D., WDFW)
- Mass Marking and Mark-Selective Fisheries: A black and white choice, or complex shades of gray? (Dave Hankin, Ph.D., Humboldt State University)
- Ocean Salmon Management Implications of Mass Marking/Mark Selective Fisheries (Michael O'Farrell, Ph.D., NMFS)

Clarifying Questions (10 minutes)

12:00 PM Lunch (Provided Onsite)

12:45 Early Afternoon Session: California Harvest and Hatchery Management

- Mass Marking of Hatchery Chinook and Mark-Selective Fisheries in California (James Phillips, CDFG)
- Central Valley salmonid hatcheries: Problems and potential solutions (Dennis Lee, retired CDFG)

Clarifying Questions (5 minutes)

1:30 Facilitated Panel 1: Hatchery Reform Management Actions

Invited Panelists: Pete Adams (NMFS Southwest Fisheries Science Center)
Andy Appleby (Washington Department of Fish & Wildlife)
Neil Manji (California Department of Fish & Game)
Brad Cavallo (Cramer Fish Sciences)
Dennis Lee (retired CDFG)

Questions for discussion:

1. What specific hatchery reform management actions could most effectively improve fitness and genetic diversity among both hatchery broodstock and natural spawning Chinook salmon?

2. What additional information is needed (if any) to determine whether or not mass marking hatchery fish is an appropriate or necessary management action?

    a. How many months or years would it take to complete this evaluation and make an informed policy decision?
    b. Is there information indicating that mass marking hatchery Chinook either is or is not an appropriate or necessary action?

3:15 Afternoon Break (Coffee and Cookies)

3:30 Facilitated Panel 2: Mass marking and mark-selective fisheries

Invited Panelists: Dave Hankin (Humboldt State University)
Kristen Ryding (Washington Department of Fish and Wildlife)
Pete Adams (NMFS Southwest Fisheries Science Center)
Lee Blankenship (Northwest Marine Technology, HSRG Co-Chair)
Carlos Garza (NMFS Southwest Fisheries Science Center)

Questions for discussion:

1. Would mark-selective fisheries be harmful or beneficial to ESA-listed and natural origin salmon relative to current harvest management practices? Why or why not?

    a. What studies or analyses support your view?

b. Are additional safeguards necessary to prevent political/public pressure for excessive harvest?

2. Is it appropriate/possible to mass mark hatchery Chinook and not implement mark-selective fisheries?

3. What information is necessary to seriously evaluate or implement mark-selective ocean fisheries off California?

5:15 – 5:30 Forum Wrap-up